

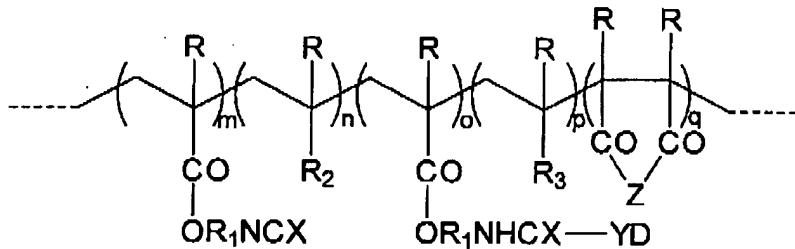
**Serial No. 09/237,125**  
**Filed: January 26, 1999**

### **Amendments to the Claims:**

This listing of claims will replace all prior versions, and listings, of claims in the application:

1. (Currently amended) A composition for an anti-reflective coating or a radiation absorbing coating containing a polymer as represented by the following General Formula II[.]

### General Formula II:



wherein

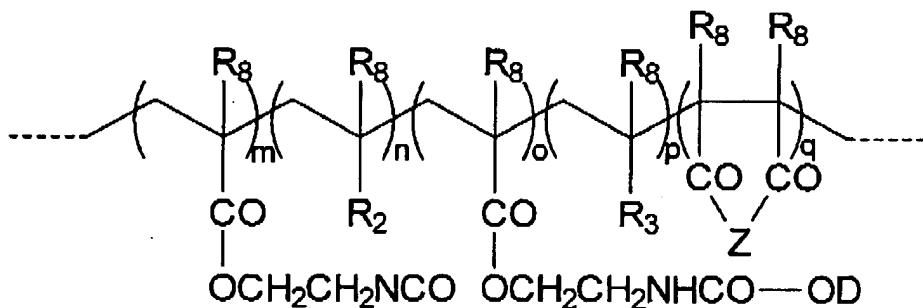
R is a hydrogen atom or an alkyl group; R<sub>1</sub> is an alkylene group, a substituted alkylene group, a cycloalkylene group, a substituted cycloalkylene group, a phenylene group or a substituted phenylene group; R<sub>2</sub> is a phenyl group, -COOH, a halogen atom, a cyano group, an alkoxy group or -COOR<sub>6</sub> in which R<sub>6</sub> is a substituted or non-substituted alkyl or aryl group or an ethylacetoacetate group; R<sub>3</sub> is -COOD; D is an organic chromophore which absorbs the exposed wavelength (100-450 nm) and represents a substituted or non-substituted[[.]] benzene ring, condensed ring or heterocyclic ring bonded directly or through an alkylene group; X is O or S; Y is O- or NR<sub>4</sub>-group in which R<sub>4</sub> is either a hydrogen atom or a substituted or non-substituted phenyl group or cyclic, linear or branched alkyl group; Z is O, ND group or NR<sub>5</sub> group in which R<sub>5</sub> is either a hydrogen atom or a substituted or non-substituted[[.]] phenyl group

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or cyclic, linear or branched alkyl group; and n, p and q are simple integers including zero and m and o are greater than zero.

2. (Currently amended) A composition for an anti-reflective coating or a radiation absorbing coating according to claim 1, wherein the polymer as represented by General Formula II is a polymer as represented by the following General Formula II'

General Formula II:



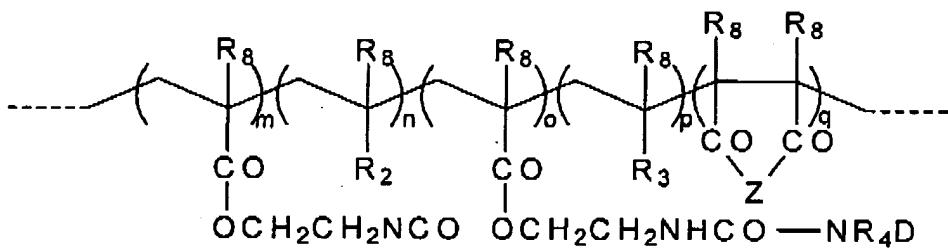
wherein

$R_8$  is a hydrogen atom or a methyl group;  $R_2$  is a phenyl group,  $-COOH$ , a halogen atom, a cyano group, an alkoxy group or  $-COOR_6$  in which  $R_6$  is a substituted or non-substituted[.] alkyl or aryl group or an ethylacetoacetate group;  $R_3$  is  $-COOD$ ; D is an organic chromophore which absorbs the exposed wavelength (100-450 nm) and represents a substituted or non-substituted[.] benzene ring, condensed ring or heterocyclic ring bonded directly or through an alkylene group; Z is O, ND group or  $NR_5$  group in which  $R_5$  is either a hydrogen atom or a substituted or non-substituted[.] phenyl group or cyclic, linear or branched alkyl group; and  $m$ ,  $n$ ,  $o$ ,  $p$  and  $q$  are simple integers including zero,  $m$  and  $o$  are greater than zero and  $m$ ,  $n$ ,  $o$ ,  $p$  and  $q$  together lie between 5 to 50,000.

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3. (Currently amended) A composition for an anti-reflective coating or a radiation absorbing coating according to claim 1, wherein the polymer as represented by General Formula II is containing a polymer as represented by the following General Formula II"

General Formula II"



wherein

$\text{R}_8$  is a hydrogen atom or a methyl group;  $\text{R}_2$  is a phenyl group, -COOH, a halogen atom, a cyano group, an alkoxy group or -COOR<sub>6</sub> in which R<sub>6</sub> is a substituted or non-substituted alkyl or aryl group or an ethylacetoacetate group; R<sub>3</sub> is -COOD; D is an organic chromophore which absorbs the exposed wavelength (100-450 nm) and represents a substituted or non-substituted, benzene ring, condensed ring or heterocyclic ring bonded directly or through an alkylene group is a group selected from phenyl, benzyl, naphthalene, substituted naphthalene, anthracene, substituted anthracene, anthraquinone, substituted anthraquinone, acridine, substituted acridine, azobenzene, substituted azobenzene, fluorene, substituted fluorene, fluorenone, substituted fluorenone, carbazole, substituted carbazole, N-alkylcarbazole, dibenzofuran, substituted dibenzofuran, phenanthrene, substituted phenanthrene, pyrene and substituted pyrene bonded directly or through an alkylene group, and the substitutions thereof are at least one group selected from alkyl, aryl, halogen, alkoxy, nitro, aldehyde, cyano, amide, dialkylamino, sulfonamide, imide, carboxylic acid, carboxylic acid ester, sulfonic acid, sulfonic acid ester, alkylamino, and arylamino; R<sub>4</sub> is

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either a hydrogen atom or a substituted or non-substituted[[.]] phenyl group or cyclic, linear or branched alkyl group; Z is O, ND group or NR<sub>5</sub> group in which R<sub>5</sub> is either a hydrogen atom or a substituted or non-substituted[[.]] phenyl group or cyclic, linear or branched alkyl group; and m, n, o, p and q are simple integers including zero, m and o are greater than zero and m, n, o, p and q together lie between 5 to 50,000.

4. (Currently amended) A composition for an anti-reflective coating or a radiation absorbing coating according to claim 2[[ or 3]], wherein D is a group selected from phenyl, benzyl, [[naphthalene]] naphthalene, substituted [[naphthalene]] naphthalene, anthracene, substituted anthracene, anthraquinone, substituted anthraquinone, acridine, substituted acridine, azobenzene, substituted azobenzene, fluorene, substituted fluorene, fluorenone, substituted fluorenone, carbazole, substituted carbazole, N-alkylcarbazole, dibenzofuran, substituted dibenzofuran, phenanthrene, substituted phenanthrene, pyrene and substituted pyrene, and the substitutions thereof are at least one group selected from alkyl, aryl, halogen, alkoxy, nitro, aldehyde, cyano, amide, dialkylamino, sulfonamide, imide, carboxylic acid, carboxylic acid ester, sulfonic acid, sulfonic acid ester, alkylamino, and arylamino.

5. (Canceled)

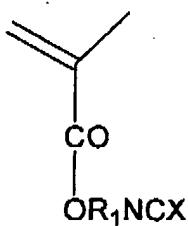
6. (Previously presented) A composition for an anti-reflective coating or a radiation absorbing coating according to claim 2 or 3, wherein n, p and q are zero and m and o together lie between 5 to 50,000 and the mole fraction of m is between 0.05 to 0.95.

7. (Canceled)

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8. (Previously presented) A composition for an anti-reflective coating or a radiation absorbing coating according to claim 2 or 3, wherein R<sub>2</sub> is -COOR<sub>6</sub> in which R<sub>6</sub> is methyl group, ethyl group, t-butyl group, isopropyl group, ethylacetacetate group, 2-hydroxyethyl group, or n-butyl group.
9. (Previously presented) A composition for an anti-reflective coating or a radiation absorbing coating according to claim 2 or 3, wherein p and q are zero and m, n and o together lie between 5 to 50,000 and the mole fraction of n is between 0.05 to 0.95.
10. (Canceled)
11. (Previously presented) A composition for an anti-reflective coating or a radiation absorbing coating according to claim 2 or 3, wherein n and q are zero and m, o and p together lie between 5 to 50,000 and the mole fraction of m is between 0.05 to 0.90.
12. (Previously presented) A composition for an anti-reflective coating or a radiation absorbing coating according to claim 2 or 3, wherein q is zero and m, n, o and p together lie between 5 to 50,000.
13. (Canceled)
14. (Previously presented) A composition for an anti-reflective coating or a radiation absorbing coating in which the polymer of claim 1 and/or the compound of General Formula III

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General Formula III

is/are further added to a composition for an anti-reflective coating or a radiation absorbing coating containing free amines or hydroxyl group containing compounds.

15. (Canceled)

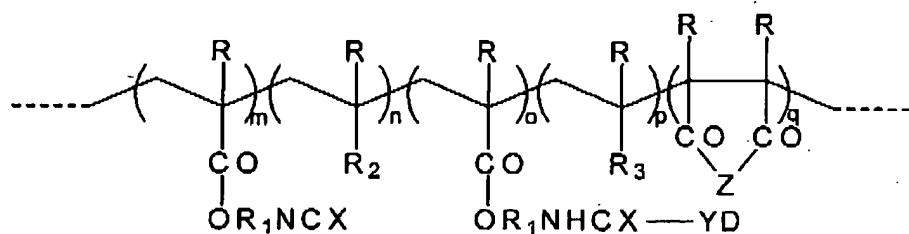
16. (Previously presented) A composition for an anti-reflective coating or a radiation absorbing coating containing the polymer of claim 1, wherein the proportion of total molar numbers of monomers and monomer units of polymer which have isocyanate group, thioisocyanate group or blocked derivatives thereof to total molar numbers of monomers and monomer units of polymers in the composition is 0.1 to 40 % by weight.

17. (Canceled)

18. (Currently amended) A polymer according to claim 17, as represented by the following General Formula II

General Formula II

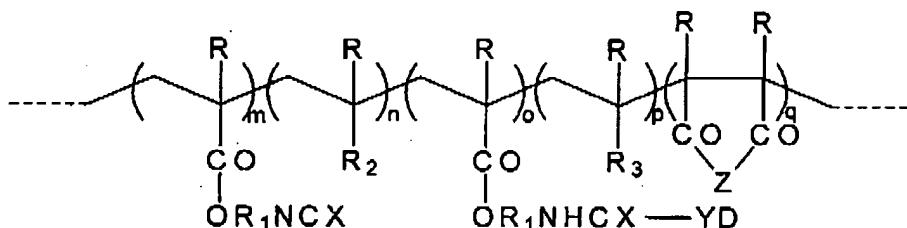
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wherein R is a hydrogen atom or a methyl group, R<sub>1</sub> is an ethylene group, X is an oxygen atom and Y is an oxygen atom, R<sub>2</sub> is a phenyl group, -COOH, a halogen atom, a cyano group, an alkoxy group or -COOR<sub>6</sub> in which R<sub>6</sub> is a substituted or non-substituted alkyl or aryl group or an ethylacetoacetate group; R<sub>3</sub> is -COOD; Z is O, ND group or NR<sub>5</sub> group in which R<sub>5</sub> is either a hydrogen atom or a substituted or non-substituted phenyl group or cyclic, linear or branched alkyl group; D is an organic chromophore which absorbs the exposed wavelength (100-450 nm) and represents a substituted or non-substituted[[,]] benzene ring, condensed ring or heterocyclic ring bonded directly or through alkylene group, and n, p and q are simple integers including zero and m and o are also simple integers including zero while at least one of them is greater than zero.

19. (Currently amended) A polymer according to claim 17, as represented by the following General Formula II  
General Formula II

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wherein R is a hydrogen atom or a methyl group, R<sub>1</sub> is an ethylene group, X is an oxygen atom, Y is -NR<sub>4</sub> group in which R<sub>4</sub> is either a hydrogen atom or a substituted or non-substituted[[],] phenyl group or cyclic, linear or branched alkyl group, R<sub>2</sub> is a phenyl group, -COOH, a halogen atom, a cyano group, an alkoxy group or -COOR<sub>6</sub> in which R<sub>6</sub> is a substituted or non-substituted alkyl or aryl group or an ethylacetoacetate group; R<sub>3</sub> is -COOD; Z is O, ND group or NR<sub>5</sub> group in which R<sub>5</sub> is either a hydrogen atom or a substituted or non-substituted phenyl group or cyclic, linear or branched alkyl group; D is an organic chromophore which absorbs the exposed wavelength (100-450 nm) and represents a substituted or non-substituted, benzene ring, condensed ring or heterocyclic ring bonded directly or through an alkylene group, is a group selected from phenyl, benzyl, naphthalene, substituted naphthalene, anthracene, substituted anthracene, anthraquinone, substituted anthraquinone, acridine, substituted acridine, azobenzene, substituted azobenzene, fluorene, substituted fluorene, fluorenone, substituted fluorenone, carbazole, substituted carbazole, N-alkylcarbazole, dibenzofuran, substituted dibenzofuran, phenanthrene, substituted phenanthrene, pyrene and substituted pyrene bonded directly or through an alkylene group, and the substitutions thereof are at least one group selected from alkyl, aryl, halogen, alkoxy, nitro, aldehyde, cyano, amide, dialkylamino, alkylamino, sulfonamide, imide, carboxylic acid, carboxylic acid ester, sulfonic acid, sulfonic acid ester, and arylamino; and m, n, p

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and q are simple integers including zero and m and o are also is a simple integers integer including zero while at least one of them is greater than zero.

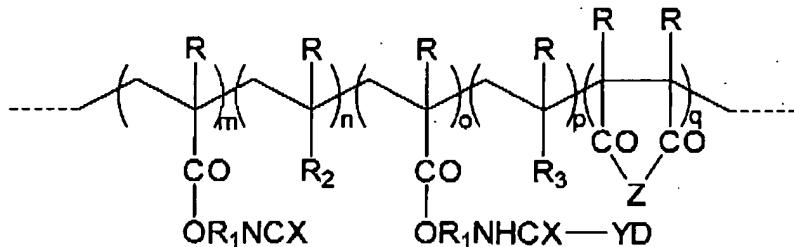
20. (Currently amended) A polymer according to claim 18 [[or 19]], wherein o is a simple integer greater than zero and D is a group selected from phenyl, benzyl, [[naphthalene]] naphthalene, substituted [[naphthalene]] naphthalene, anthracene, substituted anthracene, anthraquinone, substituted anthraquinone, acridine, substituted acridine, azobenzene, substituted azobenzene, fluorene, substituted fluorene, fluorenone, substituted fluorenone, carbazole, substituted carbazole, N-alkylcarbazole, dibenzofuran, substituted dibenzofuran, phenanthrene, substituted phenanthrene, pyrene and substituted pyrene, and the substitutions thereof are at least one group selected from alkyl, aryl, halogen, alkoxy, nitro, aldehyde, cyano, amide, dialkylamino, alkylamino, sulfonamide, imide, carboxylic acid, carboxylic acid ester, sulfonic acid, sulfonic acid ester, and arylamino.

21. (Canceled)

22. (Currently amended) A method of producing a composition for an anti-reflective coating or a radiation absorbing coating containing a polymer as represented by the following General Formula II,

General Formula II:

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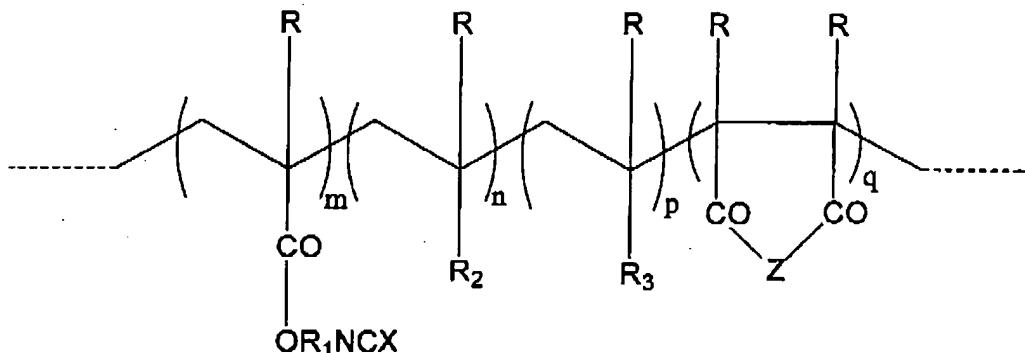


wherein

R is a hydrogen atom or an alkyl group; R<sub>1</sub> is an alkylene group, a substituted alkylene group, a cycloalkylene group, a substituted cycloalkylene group, a phenylene group or a substituted phenylene group; R<sub>2</sub> is a phenyl group, -COOH, a halogen atom, a cyano group, an alkoxy group or -COOR<sub>6</sub> in which R<sub>6</sub> is a substituted or non-substituted alkyl or aryl group or an ethylacetoacetate group; R<sub>3</sub> is -COOD; D is an organic chromophore which absorbs the exposed wavelength (100-450 nm) and represents a substituted or non-substituted benzene ring, condensed ring or heterocyclic ring bonded directly or through an alkylene group; X is O or S; Y is O or NR<sub>4</sub> group in which R<sub>4</sub> is either a hydrogen atom or a substituted or non-substituted phenyl group or cyclic, linear or branched alkyl group; Z is O, ND group or NR<sub>5</sub> group in which R<sub>5</sub> is either a hydrogen atom or a substituted or non-substituted phenyl group or cyclic, linear or branched alkyl group; and n, p and q are simple integers including zero and m and o are also simple integers including zero while at least one of them is greater than zero which comprises the following steps:

- a) dissolving a polymer having the formula

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wherein  $R$ ,  $R_1$ ,  $R_2$ ,  $R_3$ ,  $X$ ,  $Z$ ,  $m$ ,  $n$ ,  $p$ , and  $q$  are as defined above having isocyanate groups in one or more solvents, and

- b) reacting the isocyanate groups either partially or fully with amino aromatic and/or hydroxyl aromatic chromophores at room temperature or elevated temperature if necessary.

23. (Previously presented) A method of forming an anti-reflective coating or a radiation absorbing coating which comprises the following steps:

- a) filtering the composition for an anti-reflective coating or a radiation absorbing coating produced by the method of claim 22 with 0.5 and 0.2 micron filters,
- b) applying the filtered solution directly onto a semiconductor substrate, and
- c) baking the coated substrate at 50 to 250 °C.

24. (Previously presented) A method of producing a composition for an anti-reflective coating or a radiation absorbing coating of claim 22, wherein the solvent is cyclopentanone, cyclohexanone, butyrolactone, propylene glycol monomethyl ether acetate, 2-heptanone, ethyl lactate, ethyl-3-ethoxy propanate, ethylene glycol monoethyl acetate, or methyl-3-methoxy propanate individually or mixtures thereof.

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25. (Previously presented) A method of forming an anti-reflective coating or a radiation absorbing coating which comprises the following steps: a) applying the composition for an anti-reflective coating or a radiation absorbing coating of claim 1, 2 or 3 onto a semiconductor substrate, and b) removing the solvent at least partially by baking to form a substrate coated with an anti-reflective coating or a radiation absorbing coating.

26. (Previously presented) An anti-reflective coating or a radiation absorbing coating formed by the method of claim 23.

27. (Canceled)

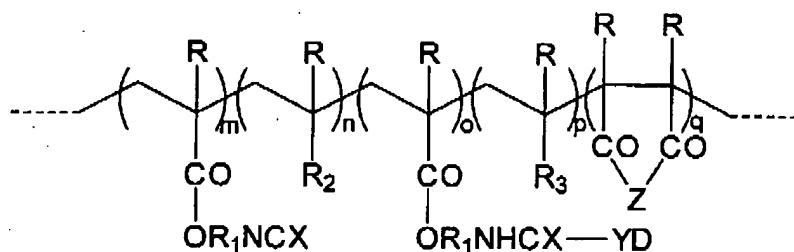
28. (Previously presented) An anti-reflective coating or a radiation absorbing coating formed by the method of claim 25.

29. (Canceled)

30. (Currently amended) A composition for an anti-reflective coating or a radiation absorbing coating containing a polymer as represented by the following General Formula II

General Formula II:

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wherein

R is a hydrogen atom or a methyl group; R<sub>1</sub> is —CH<sub>2</sub>CH<sub>2</sub>—, or a phenylene group; R<sub>2</sub> is a phenyl group, -COOH, a halogen atom, a cyano group, or -COOR<sub>6</sub> in which R<sub>6</sub> is a member selected from the group consisting of methyl group, ethyl group, t-butyl group, isopropyl group, ethylacetoacetate group, 2-hydroxyethyl group, and n-butyl group; R<sub>3</sub> is -COOD; D is a member selected from the group consisting of phenyl, benzyl, [[naphthalene]] naphthalene, substituted [[naphthalene]] naphthalene, anthracene, substituted anthracene, anthraquinone, substituted anthraquinone, acridine, substituted acridine, azobenzene, substituted azobenzene, fluorene, substituted fluorene, fluorenone, substituted fluorenone, carbazole, substituted carbazole, dibenzofuran, substituted dibenzofuran, phenanthrene, substituted phenanthrene, pyrene and substituted pyrene, bonded directly or through a methylene group, wherein the substituents are at least one member selected from the group consisting of nitro, aldehyde, cyano, carboxylic acid, sulfonic acid; X is O or S; Y is O or NR<sub>4</sub> group in which R<sub>4</sub> is either a hydrogen atom or a phenyl group; Z is O, ND group or NR<sub>5</sub> group in which R<sub>5</sub> is either a hydrogen atom or a phenyl group; and m, n, o, p and q are simple integers including zero provided at least one of the following conditions are met:

- (1) n, p and q are zero, sum of m and o is between 5 to 50,000 and mol fraction of m is between 0.05 to 0.95,

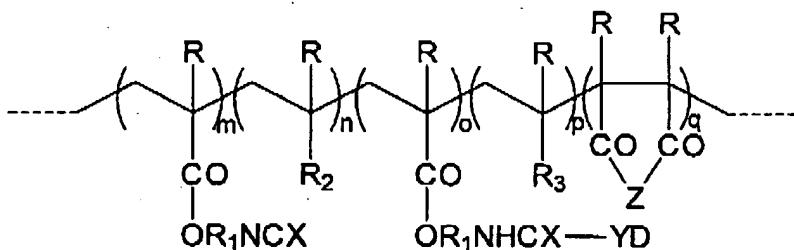
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- (2) p and q are zero, sum of m, n and o is between 5 to 50,000 and mol fraction of n is between 0.05 to 0.95,
- (3) n and p are zero, sum of m, o and q is between 5 to 50,000 and mol fraction of q is between 0.05 to 0.50,
- (4) n and q are zero, sum of m, o and p is between 5 to 50,000 and mol fraction of m is between 0.05 to 0.90, and
- (5) q is zero and sum of m, n, o and p is between 5 to 50,000.

31. (Previously presented) The composition of claim 30, wherein R<sub>1</sub> is -CH<sub>2</sub>CH<sub>2</sub>-; R<sub>2</sub> is -COOR<sub>6</sub>; R<sub>4</sub> is a hydrogen atom; and R<sub>5</sub> is a hydrogen atom.

32. (Currently Amended) A composition for an anti-reflective coating or a radiation absorbing coating containing a polymer as represented by the following General Formula II and/or blocked derivatives thereof,

General Formula II:



wherein

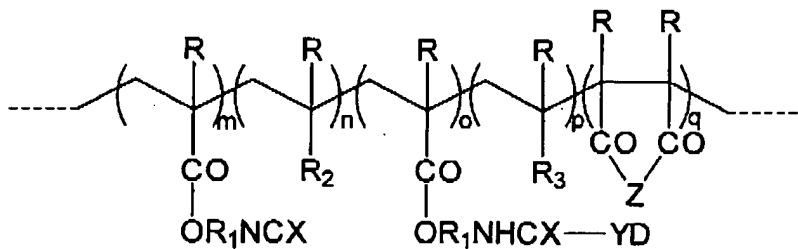
R is a hydrogen atom or an alkyl group; R<sub>1</sub> is an alkylene group, a substituted alkylene group, a cycloalkylene group, a substituted cycloalkylene group, a phenylene group or a substituted phenylene group; R<sub>2</sub> is a phenyl group, -COOH, a halogen atom, a cyano group, an alkoxy group or -COOR<sub>6</sub> in which R<sub>6</sub> is a substituted or non-substituted alkyl or aryl group or an ethylacetoacetate group; R<sub>3</sub> is -COOD; D is an

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organic chromophore which absorbs the exposed wavelength (100-450 nm) and represents a substituted or non-substituted[[],] benzene ring, condensed ring or heterocyclic ring bonded directly or through an alkylene group; X is O or S; Y is O or NR<sub>4</sub> group in which R<sub>4</sub> is either a hydrogen atom or a substituted or non-substituted phenyl group or cyclic, linear or branched alkyl group; Z is O, ND group or NR<sub>5</sub> group in which R<sub>5</sub> is either a hydrogen atom or a substituted or non-substituted, phenyl group or cyclic, linear or branched alkyl group; and n, p and q are simple integers including zero and m and o also simple integers greater than zero; wherein the proportion of total molar numbers of monomer units of polymer which have isocyanate group, thioisocyanate group or blocked derivatives thereof to total molar numbers of monomers and monomer units of polymers in the composition is 0.1 to 40 mol%.

33. (Currently Amended) A composition for an anti-reflective coating or a radiation absorbing coating containing a polymer as represented by the following General Formula II[[],]

General Formula II:



wherein

R is a hydrogen atom or an alkyl group; R<sub>1</sub> is an alkylene group, a substituted alkylene group, a cycloalkylene group, a substituted cycloalkylene group, a phenylene group or a substituted phenylene group; R<sub>2</sub> is a phenyl group, -COOH, a halogen atom, a cyano group, an alkoxy group or -COOR<sub>6</sub> in which R<sub>6</sub> is a substituted or non-

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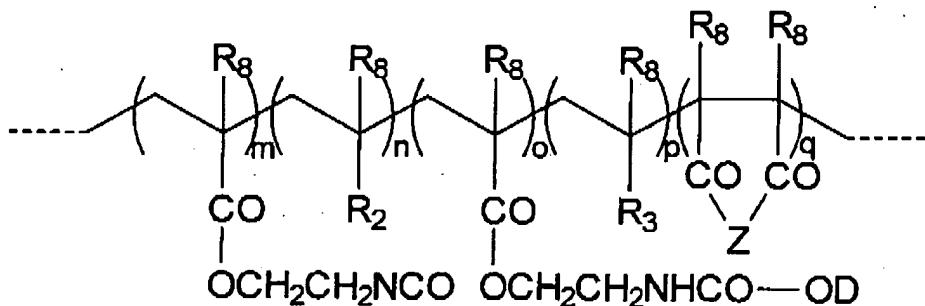
substituted alkyl or aryl group or an ethylacetoacetate group; R<sub>3</sub> is -COOD; D is an organic chromophore which absorbs the exposed wavelength (100-450 nm) and represents a substituted or non-substituted[[,]] benzene ring, condensed ring or heterocyclic ring bonded directly or through an alkylene group; X is O or S; Y is O-~~or NR<sub>4</sub>-group in which R<sub>4</sub> is either a hydrogen atom or a substituted or non-substituted phenyl group or cyclic, linear or branched alkyl group~~; Z is O, ND group or NR<sub>5</sub> group in which R<sub>5</sub> is either a hydrogen atom or a substituted or non-substituted, phenyl group or cyclic, linear or branched alkyl group; and n, p and q are simple integers including zero and m and o are simple integers greater than 0; further provided that at least one of the following conditions is met : (1) m and q are both greater than 0; (2) n and o are both greater than 0; (3) n and p are both greater than 0; (4) m and p are both greater than 0; and (5) m, n, and o are all greater than 0.

34. (Previously presented) The composition of claim 33, wherein R<sub>1</sub> is -CH<sub>2</sub>CH<sub>2</sub>-; R<sub>2</sub> is -COOR<sub>6</sub>; R<sub>4</sub> is a hydrogen atom; and R<sub>5</sub> is a hydrogen atom.

35. (Currently Amended) A composition for an anti-reflective coating or a radiation absorbing coating ~~containing according to claim 33, wherein the polymer as represented by General Formula II is a polymer as represented by the following General Formula II'~~

**General Formula II'**

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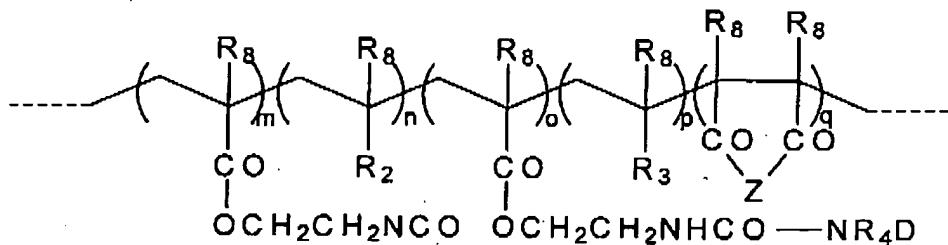
wherein

R<sub>8</sub> is a hydrogen atom or a methyl group; R<sub>2</sub> is a phenyl group, -COOH, a halogen atom, a cyano group, an alkoxy group or -COOR<sub>6</sub> in which R<sub>6</sub> is a substituted or non-substituted[.] alkyl or aryl group or an ethylacetoacetate group; R<sub>3</sub> is -COOD; D is an organic chromophore which absorbs the exposed wavelength (100-450 nm) and represents a substituted or non-substituted[.] benzene ring, condensed ring or heterocyclic ring bonded directly or through an alkylene group; Z is O, ND group or NR<sub>5</sub> group in which R<sub>5</sub> is either a hydrogen atom or a substituted or non-substituted[.] phenyl group or cyclic, linear or branched alkyl group; and m, n, o, p and q are simple integers including zero while m and o are greater than zero and m, n, o, p and q together lie between 5 to 50,000; further provided that at least one of the following conditions is met: (1) m and q are both greater than 0; (2) n and o are both greater than 0; (3) n and p are both greater than 0; (4) m and p are both greater than 0; and (5) m, n, and o are all greater than 0.

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36. (Currently Amended) A composition for an anti-reflective coating or a radiation absorbing coating containing according to claim 33, wherein the polymer as represented by General Formula II is a polymer as represented by the following General Formula II"

**General Formula II"**



wherein

R<sub>8</sub> is a hydrogen atom or a methyl group; R<sub>2</sub> is a phenyl group, -COOH, a halogen atom, a cyano group, an alkoxy group or -COOR<sub>6</sub> in which R<sub>6</sub> is a substituted or non-substituted[[,]] alkyl or aryl group or an ethylacetacetate group; R<sub>3</sub> is -COOD; D is an organic chromophore which absorbs the exposed wavelength (100-450 nm) and represents a substituted or non-substituted, benzene ring, condensed ring or heterocyclic ring bonded directly or through an alkylene group is a group selected from phenyl, benzyl, naphthalene, substituted naphthalene, anthracene, substituted anthracene, anthraquinone, substituted anthraquinone, acridine, substituted acridine, azobenzene, substituted azobenzene, fluorene, substituted fluorene, fluorenone, substituted fluorenone, carbazole, substituted carbazole, N-alkylcarbazole, dibenzofuran, substituted dibenzofuran, phenanthrene, substituted phenanthrene, pyrene and substituted pyrene bonded directly or through an alkylene group, and the substitutions thereof are at least one group selected from alkyl, aryl, halogen, alkoxy, nitro, aldehyde, cyano, amide, dialkylamino, sulfonamide, imide, carboxylic acid, carboxylic acid ester, sulfonic acid, sulfonic acid ester, alkylamino, and arylamino;; R<sub>4</sub> is

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either a hydrogen atom or a substituted or non-substituted[[,]] phenyl group or cyclic, linear or branched alkyl group; Z is O, ND group or NR<sub>5</sub> group in which R<sub>5</sub> is either a hydrogen atom or a substituted or non-substituted[[,]] phenyl group or cyclic, linear or branched alkyl group; and m, n, o, p and q are simple integers including zero while m and o are greater than zero and m, n, o, p and q together lie between 5 to 50; further provided that at least one of the following conditions is met : (1) m and q are both greater than 0; (2) n and o are both greater than 0; (3) n and p are both greater than 0; (4) m and p are both greater than 0; and (5) m, n, and o are all greater than 0.

37. (Currently Amended) A composition for an anti-reflective coating or a radiation absorbing coating according to claim 35[[ or 36]], wherein D is a group selected from phenyl, benzyl, [[naphthalene]] naphthalene, substituted [[naphthalene]] naphthalene, anthracene, substituted anthracene, anthraquinone, substituted anthraquinone, acridine, substituted acridine, azobenzene, substituted azobenzene, fluorene, substituted fluorene, fluorenone, substituted fluorenone, carbazole, substituted carbazole, N-alkylcarbazole, dibenzofuran, substituted dibenzofuran, phenanthrene, substituted phenanthrene, pyrene and substituted pyrene, and the substitutions thereof are at least one group selected from alkyl, aryl, halogen, alkoxy, nitro, aldehyde, cyano, amide, dialkylamino, sulfonamide, imide, carboxylic acid, carboxylic acid ester, sulfonic acid, sulfonic acid ester, alkylamino, and arylamino.